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CURRENT ACTIVITIES

ATLANTIC PROVINCES

Aerial Spraying Against Spruce Budworm in New Brunswick—1958.—Operations in 1958 involved 2.6 million acres of spraying at the customary dosage of ½ lb. DDT in ½ U.S. gal. oil solvent per acre. Since 1952 this control program has covered 6.0 million acres of highly susceptible forest in northern and central New Brunswick one or more times. Twenty-six per cent of the area has been sprayed once, 34 per cent twice, 31 per cent three times, 8 per cent four times and less than 1 per cent five times in seven years.

As in previous years, operations in 1958 were carried out by Forest Protection Ltd., B. W. Flieger, Manager. About 1.75 million acres of critically damaged forest were resprayed in north-central and northwestern parts of the Province, and 850,000 acres of new high hazard were treated for the first time to the south and west of previous spraying in York, Carleton, and Victoria Counties. Operational bases included nine of the previously constructed airstrips and Fredericton Municipal Airport. The aerial fleet included 76 Stearman and 12 TBM Grumman Avenger spray planes and 17 single-engine Cessna observation planes. Customary flying and inspection procedures applied in the case of Stearmans. Avengers, which were used on this operation for the first time against spruce budworm in Canada, were also flown in pairs, but were under the full-time surveillance of an inspection pilot in radio contact. Insecticide again was formulated by Forest Protection Ltd. at a plant in Dalhousie, N.B., during the winter season and most of it was transferred to storage at airstrip sites by tank trucks before spring thaws restricted road transport. Costs of the entire operation again were reduced from previous years, averaging 55-60 cents per acre.

For the second year, timing of operations in various parts of the Province was adjusted in accordance with a map of seasonal development for northern New Brunswick, drawn for the purpose in the immediate prespray period. This map showed only minor variations from the one drawn by the same techniques in 1957. Complications in estimating optimum spraying dates arose for two reasons. In central parts of the Province early season shoot growth was considerably advanced over larval development by comparison with other years. This reduced the chances of severe foliage loss and called for later spraying than that customarily recommended in New Brunswick, to achieve the best results against relatively well-protected larvae. Later timing would also have been of advantage in resprayed areas where larval populations proved generally lighter than predicted by the 1957 egg survey. As a result, recommended spraying dates, estimated as early in the season as possible to facilitate operational planning, proved generally earlier than optimum.

Extensive postspray sampling at over 400 sample points in sprayed and unsprayed areas showed that spraying reduced budworm survival on fir by approximately 80% in both new and previously-sprayed areas. This is slightly lower than in previous years but it should be noted that this method of expressing results fails to reveal the degree to which infestation has fallen off in affected areas as shown in the following table.

—	Mean No. Budworms Surviving per 18-inch Branch		% Population reduction	Net foliage saved. %
	Unsprayed Check	Sprayed Areas		
1955	11.9	2.0	83%	41%
1956	18.8	2.1	89	25
1957	7.7	1.1	85	40
1958 Resprayed areas	0.5	0.1	80	11
1958 Newly-sprayed areas	2.5	0.5	80	34

It was estimated that loss of current foliage on fir was reduced from 70 to 36 per cent in newly-sprayed areas and from 17 per cent to a trace in resprayed areas. Sampling on spruce (mainly white) at the same locations revealed nearly equivalent budworm populations, but somewhat lower percentage of control: 75 per cent on newly sprayed areas, reducing new foliage loss from 62 to 34 per cent, 52 per cent on resprayed areas reducing defoliation from 14 per cent to a trace.

Changes were also evident in the abundance of other lepidopterous defoliators. Prespray sampling indicated a widespread abundance of *Zeiraphera* spp. principally on white spruce. Owing to prior emergence, no measure of the abundance of these insects was obtained from the postspray sampling, but the characteristic redness of affected trees, caused by the prolonged retention of bud scales on the tips of affected shoots, increased the difficulty of assessing spruce budworm attack on aerial surveys. The species found in postspray samples occurred in smaller absolute numbers than in previous years but were more numerous in proportion to spruce budworms, averaging 17 per cent as abundant on fir and 38 per cent as abundant on spruce for outbreak areas as a whole. They were most abundant in north-central areas where they exceeded budworm numbers by 54 per cent on fir and 73 per cent on spruce. The most common associated species on fir was *Griselda radicana* Wlshm. followed by *Feralia* spp. and *Dioryctria reniculella* (Grote). The last-named was most abundant on spruce, followed by the other two in order.

The postspray survey also showed a relative increase in parasite cocoons and puparia over 1957; in ratio to spruce budworm they averaged 1:2.2 on fir and 1:2.4 on spruce. The species occurring in the largest number of collections was *Apanteles fumiferanae* Vier. followed by *Meteorus trachynotus* Vier. (see below). *Glypta fumiferanae* (Vier.) occurred infrequently in northern areas of old outbreak but remained relatively abundant in southern areas of more recent attack. Among the predacious forms, spiders were by far the most abundant and showed an increase over previous years. Insect predators were of about the same order of abundance and like spiders were most numerous in southeastern outbreak areas. Aphids and mites again occurred in inconsequential numbers.

Egg surveys were again carried out with the assistance of personnel and facilities of Forest Protection Ltd. Living and laboratory facilities for the crew of up to 50 men were provided in the Maritime Forest Ranger School instead of at field camps as in previous years. Results indicate a further drastic reduction in outbreak extent and severity in 1959. This is shown by the following table:

—	Per cent of outbreak area in which egg populations were			
	High	Moderate	Low	Zero
1956	55%	12%	29%	4%
1957	10	31	43	16
1958	2	5	55	38

Even these data fail to indicate the total extent to which infestation has diminished; average egg-mass numbers in "High" areas (counts predominantly over 240 egg masses per 100 sq. ft. foliage, sufficient to cause 70 per cent or greater loss of new shoot growth) declined from 522 in 1956 to 452 in 1957 and 314 in 1958. Eggs were found to be virtually absent from large areas of oldest outbreak in Restigouche, Madawaska, and Victoria Counties and occurred only in very low numbers practically throughout the remain-

ing sprayed areas. Remnants of moderate to severe outbreak occur along the southern periphery of sprayed areas between Fredericton on the Saint John River and Blackville on the Miramichi. The few "High" counts recorded (13 out of 804 samples) were concentrated chiefly in two relatively small areas within 25 miles east and west of Fredericton. Even in these areas the scattered distribution of high counts and prospects of increased natural control suggest that attack in 1959 is unlikely to measure up to expectations of previous experience.

No large-scale moth flights were reported in 1958 and for the second year this factor failed to influence results in sprayed areas.

After two seasons of severe decline, the outbreak has now reached a stage at which complete collapse is likely, possibly by 1959. A major contributing factor has been unfavourable weather, as reported by J. R. Blais for the Lower St. Lawrence-Gaspe area in Quebec (Bi-Monthly Progress Rept. 14(6), 1958) and corroborated by D. O. Greenbank from studies of the Green River Project in New Brunswick. Development of larvae to the pupal and adult stages occurred as late in the season in 1958 as in any previous year, marking the third successive year of relatively delayed larval development. This is related to an increase in mortality due to disease. According to M. M. Nielson mortality of late-instar larvae from disease in the Green River area increased from 12 per cent in 1956 to 18 per cent in 1957 and 21 per cent in 1958. A number of samples from the Gaspe Peninsula were also analysed in 1958 for purposes of comparison. These showed about 50 per cent higher mortality than in New Brunswick. In both regions, Microsporidia accounted for more than half the mortality. Particularly noticeable in 1958 was a large increase in aggregate parasitism[1] of the larval and pupal stages, averaging approximately a four-fold increase on permanent plots in the older outbreak areas of north-central New Brunswick: from 14 to 64 per cent on plots in sprayed areas and from 17 to 67 per cent in unsprayed check plots. The most remarkable increase occurred in the case of *M. trachynotus,* a species characteristic of declining outbreaks, from less than 5 per cent in 1957 to an average of 43 per cent for all permanent plots in 1958. Next in importance were *A. fumiferanae* showing a 2.5-fold increase to 13 per cent and chalcids (mainly *Amblymerus verditer* Nort.) an 18-fold increase to 11 per cent. The only common species showing a decrease was *G. fumiferanae* down to less than 1 per cent. *Itoplectis conquisitor* (Say), a species mentioned by Blais along with *M. trachynotus* as occurring in "greatly increased proportions" in Quebec in 1958 caused less than 3 per cent parasitism on New Brunswick plots and did not increase over 1957. Other natural control factors have also increased in effectiveness. In some instances, low residual budworm populations on some study plots tended to disappear in late larval and pupal stages in a manner suggestive of removal by predators. Increases were apparent in 1957 and 1958 in the degree of population reduction between eggs and established larvae the following spring, from causes that have not yet been fully analysed. As one result, predictions of defoliation based on egg counts since 1957 have tended to be overestimates.

Reduction of heavy attack, combined with favourable growing conditions and protection by spraying, permitted a very substantial improvement in 1958 in the growth and recovery of host trees. A measure of this improvement is provided in the following comparison of results of 1957 and 1958 aerial surveys by Forest Protection Ltd. of forest conditions in sprayed areas. This is based on appraisals from low-lying aircraft of defoliation and damage in 1202 spray blocks.

Condition of host stands	Percentage of spray blocks showing assessment conditions	
	1957	1958
No damage evident	0.9	2.7
Light damage	17.0	46.4
Moderate damage	54.3	39.0
Severe damage, tree condition critical	26.0	10.7
Very severe damage, mortality present or imminent	1.8	1.2

There is little doubt that the forest condition will continue to improve in 1959. A degree of recovery is also evident in surviving trees in unsprayed check areas. Mortality is virtually complete in many of the mature and overmature stands in these areas, however, and approaches 50 per cent of all fir stems 2 inches DBH and over the full range of stand types and age conditions. The latter figure is considered a fair estimate of conditions that would now exist over a large area if the trees had not been sprayed.

The outbreak reached its greatest extent in 1957 when the area under moderate to severe attack covered nearly 13 millions acres, about 85 per cent of the total forested area of the Province. Also evident in 1957 were the first signs of a slackening in outbreak intensity: egg surveys of the 1957-58 generation showed substantially reduced populations over most of the Province, particularly in northern areas of oldest attack (Bi-Monthly Prog. Rept. 14(3), 1958). As predicted, moderate to heavy feeding in 1958 was restricted to about three millions acres around the periphery of previously sprayed areas in Central Carleton and York Counties, northern Sunbury and Queens Counties, and eastern parts of Gloucester, Northumberland, and Kent Counties. Signs of outbreak recession were also evident in the 1958 infestation pattern from: (1) the relatively discontinuous nature of heavy attack even in the most severely affected areas; (2) unexpectedly light damage in older outbreak areas where egg surveys had indicated moderate infestation; and (3) a decided reduction in the extent and severity of infestation in more-recently infested areas in southern parts of the Province. No spraying is planned for 1959 since surveys have failed to show any areas in which the combined hazard of current infestation and previous damage is sufficient to threaten the life of trees.

Assuming the outbreak is about to end, the objectives of seven years' spraying have been largely achieved. Except for some relatively small patches, the threatened forest is still alive and growing while unsprayed check areas provide proof that the alternative would have been widespread destruction of present and future pulpwood supplies in the Province. There is little or no evidence of serious adverse effects on the natural control of the budworm or of increases in other pests. Spraying does not appear to have prolonged the outbreak by preserving the food supply of the larvae and the idea no longer seems tenable that starvation of the insect and destruction of the susceptible forest are necessary prerequisites for the decline of full-scale outbreaks in this region. However, since the susceptible forest condition that initially proved favourable for outbreak development remains largely intact, the question remains whether a resurgence is imminent, depending only on a slackening in natural control in combination with the occurrence of favourable weather. There seems little doubt, however, at the present level of natural control, that the New Brunswick outbreak will remain at a low level for at least the next two or three years.—F. E. Webb, D. R. Macdonald, D. G. Cameron.

BRITISH COLUMBIA

Further Observations on Pole Blight and Climate.— Observations on permanent sample plots have indicated that in the past few years there has been some improvement in the pole blight condition of western white pine (Molnar, A. C. and R. G. McMinn. Bi-Mo. Prog. Rept. 14(3), 1958). Wellington (Bi-Mo. Prog. Rept. 10(6), 1954) has shown that during many of the years he analysed (1930-54), higher-than-average summer temperatures and lower-than-average summer rainfall occurred in that portion of the white pine region in which pole blight was present, but that such differences were less pronounced in the pole-blight-free area of the southern portion of the white pine range. Weather records, as well as dendrochronological studies and observations on the retreat of glaciers, indicate that this warm, dry period may have begun as early as 1917 in the United States (Leaphart, C. D. Jour. For. 56(10), 1958). If the occurrence of pole blight were related to unfavourable climatic conditions, their alleviation might bring about improvement in some pole-blight-affected trees. The records from various weather stations in British Columbia were therefore analysed to ascertain if the weather of recent years, during which this improvement has been noted, has in fact been cooler and moister than it was in the previous period.

The relative warmth of each year for which daily maximum temperature records are available was assessed for the months May through August by summing the number of degrees Fahrenheit by which each maximum exceeded 80°F. This 80°F. temperature was chosen arbitrarily to indicate the occurrence of a hot day, and summation of the degrees in excess of 80°F. gave a weighted value for each season. These values were plotted together with total May through August rainfall to show relative trends from year to year. Fig. 1 presents these trends for three stations which had virtually unbroken records. Table 1 shows the percentage of years in which the frequency of rainy days, that is days in which at least a trace was recorded, was lower than average.

It is apparent that during the years preceding 1946, many summers had above average temperatures and below average

[1] % Aggregate parasitism = a+(1-a)b+(1-a)(1-b)c, where
a = % early larval parasitism
b = % late larval parasitism
c = % pupal parasitism

rainfall. Such conditions were particularly pronounced during the decade 1930-40, when this trend was only interrupted by occasional summers in which temperatures and rainfall corresponded to, or were cooler and moister than, the 1922-57 averages. On the other hand, since 1946, cool, wet summers have outnumbered summers which were hotter and drier than average.

If the hot, dry portion of this cycle were indeed a major factor in the occurrence of pole blight, the question might be raised why recovery was not observed until as late as 1953 and some trees have continued to decline. Possible explanations may lie in the apparently systemic nature of pole blight and the occurrence of extreme weather conditions even subsequent to 1946.

If pole blight is visualized as a gradual decline in vigour caused by and resulting in excessive rootlet mortality, which was originally induced by unusually dry atmospheric and edaphic conditions, then those trees in which decline had reached an advanced stage might be slow to recover or even fail to respond to more favourable enviromental conditions. Furthermore, root pathogens, such as *Armillaria mellea,* which are known to be very prevalent in the pine stands of this region, could retard recovery of weakened trees by restricting water or nutrient uptake. Sub-optimal soil nutrient regimes might also play a part.

The occurrence of occasional hot, dry summers during the cooler portion of a climatic cycle presumably has little lasting influence on vigorous trees because reserves carry them through to the following growing season. On the other hand, when trees are in a low state of vigour, even the intermittent occurrence of hot, dry years could delay recovery or promote further decline. Such years have recurred. At Kaslo, for example, the summers of 1951 and 1956 were hotter than average and rainfall in 1949 and 1950 was less than average. Similar departures from the cool, moist trend have occurred at other stations in these or in other years. Conversely, even moist years might favour the activity of root pathogens more than that of a tree in which decline was sufficiently advanced for speedy recovery to be unlikely.

The coincidence of pole blight with the hot, dry part of a climatic cycle supports the hypothesis that this disease is related to the occurrence of such conditions. This view is further corroborated by the fact that a reduced rate of symptom intensification and recovery trend in some trees was preceded and accompanied by cooler, moister summers.—R. G. McMinn and A. C. Molnar.

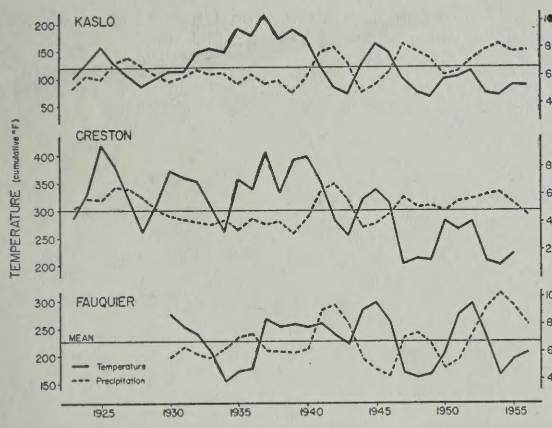

Fig. 1. Variation in May through August temperature and precipitation at three stations in the white pine region of British Columbia. Temperature values are the summation of the number of degrees by which daily maximum readings exceeded 80°F. Temperature and precipitation curves subjected to three-point smoothing.

TABLE 1.

Percentage of Years with Lower than Average Occurrence of Rainy Days (Days Recording Trace or More) at Various Stations in the White Pine Region of British Columbia, 1922-1957.

—	1922–46	1947–57
KASLO	55	10
CRESTON	65	20
FAUQUIER*	60	25
NEW DENVER*	55	20
ROSSLAND	65	20
KINGSGATE*	50	20

* 1928–46.

The Balsam Woolly Aphid, *Adelges piceae* (Ratz.), in British Columbia.—The first authentic record of balsam woolly aphid in British Columbia was reported by Dr. K. Graham of the University of British Columbia on May 12, 1958. A single amabilis fir, *Abies amabilis* (Dougl.) Forb., in North Vancouver was found suffering from a heavy stem attack as well as severe gouting. Dr. R. E. Balch, Fredericton, N.B., confirmed the identification of the insect. The tree had been brought down from Grouse Mountain and transplanted about 30 years ago. Subsequent examination showed amabilis fir on the Grouse Mountain road to be heavily infested from altitudes of 1,400 to 3,500 feet. Amabilis fir was also found under attack in Mt. Seymour Provincial Park, Hollyburn Mountain, inside the Capilino Watershed gate, and three miles inland from Porteau, which is 7 miles south of Britannia Beach. Five grand fir, *Abis grandis* (Dougl.) Lindl., at Queen's Park, New Westminster, and three grand fir on Ross Crescent, West Vancouver, were also attacked.

Living material from Mt. Seymour, Grouse Mountain, and Queen's Park was carefully examined. All features, including the presence of broad wax ribbons on first-instar larvae, were characteristic of *Adelges piceae.*

Three strips were run in Mt. Seymour Provincial Park and on Grouse Mountain. The results are shown in Table 1. The stands are predominantly hemlock with amabilis fir making up about 26 per cent of the stems. The percentage of amabilis fir attacked was over 80 in two strips; in the third strip only 20 per cent of the amabilis fir was definitely attacked, but 61.5 per cent was probably suffering from gout.

All amabilis fir on the three strips were tallied by crown class, D.B.H., and type of attack. Trees ranging from 6 to 36 inches D.B.H., and all crown classes from suppressed to dominant were attacked. Twenty-eight per cent of all amabilis fir had stem attack.

About a dozen trees have already died, most of these in 1958. Many tops have been killed back as much as 10 feet by gout, indicative of a well advanced state of attack. Tree mortality can be expected to increase in the next few years.

Twenty-one other localities in the lower Fraser River area were examined late in 1958 but no balsam woolly aphid was found. A survey of balsam stands within a 20-mile radius of Victoria also failed to find any trace of attack.

Dr. R. E. Balch (Studies of the Balsam Woolly Aphid, *Adelges piceae* (Ratz.) and its Effects on Balsam Fir, *Abies balsamea* (L.) Mill. Can. Dept. Agr. Pub. 867. 1952) found it possible to date the year in which balsam fir was attacked by balsam woolly aphid by the presence of "rotholz" or abnormally dark wood in the annual rings. Two trees, one from Grouse Mountain and one from Mt. Seymour, which had died in 1958 from combined stem and gout attack, were cut and sectioned.

The tree from Grouse Mountain was 97 feet tall with a D.B.H. of 10 inches. A light stem attack started 7 feet above the ground, and extended for 40 feet into the lower crown. Gout was heavy, particularly in the upper crown with the top dead about $2\frac{1}{2}$ feet to a diameter of $1\frac{1}{4}$ inches before the tree died. The presence of "rotholz" was more pronounced in the crown section, and indicated the attack occurred at least eight and probably ten years ago. There was a gradual reduction in radial growth in the last six years, with a more pronounced reduction in the last two rings. Annual increment in the last year was narrowest at D.B.H.

The tree from Mt. Seymour was 65 feet tall with a D.B.H. of 8 inches. The stem attack was light from the ground to 8 feet, then heavy to the base of the crown 30 feet above the ground level. Gout was light on the lower third of the crown, and was progressively heavier to the top third where the top had been killed back several feet. The first attack occurred at least eight years ago, and probably as long as eleven years ago. Judging from the presence of "rotholz" the attack was light up to 1953, then heavy from 1954 to 1956. At this point some of the cambium was killed, resulting in a considerable reduction in radial growth the last two years.—G. T. Silver.

TABLE 1

Stand Composition by Number of Stems and Amabilis Fir Attacked by Balsam Woolly Aphid. October, 1958.

Location	Length of 1 ch. strips	No. stems				% A. fir in stand	% A. fir attacked
		Hem-lock	D. fir	Cedar	A. fir		
Mt. Seymour No. 1	10.5	93	3	8	36	25.7	80.5
Grouse Mtn. No. 2	9.0	97	0	21	39	24.8	20.5*
Grouse Mtn. No. 3	9.0	40	0	0	19	32.2	84.2

*A further 61.5% of amabilis fir probably suffering from "gout" attack.

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